Microcalorimeters

Constellation-X Technology and Project Status Meeting

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for Microcalorimeter Team

Progress since October ‘99 FST Meeting:

TES @ GSFC

- Reproducible T_c in Mo/Au bilayers (±5 mK).
- Installation and preliminary verification of 4-channel SQUID array read-out in dilution refrigerator testbed.
- High RRR (10) in latest devices and very preliminary x-ray testing looks promising.
- Demonstration that local Nb shielding sufficient for running SQUIDs in our ADR with unshielded magnet.
- Design of pathfinder photolithography mask set for testing device components critical to making Constellation-X arrays nearly complete.

Setback: leak in dilution refrigerator!

TES @ NIST

- Fabrication of Mo/Cu TES detectors with variable thermal conductance and integral 2 micron Bi absorber. Devices are in test now and results are said to be good.

NTD @ SAO

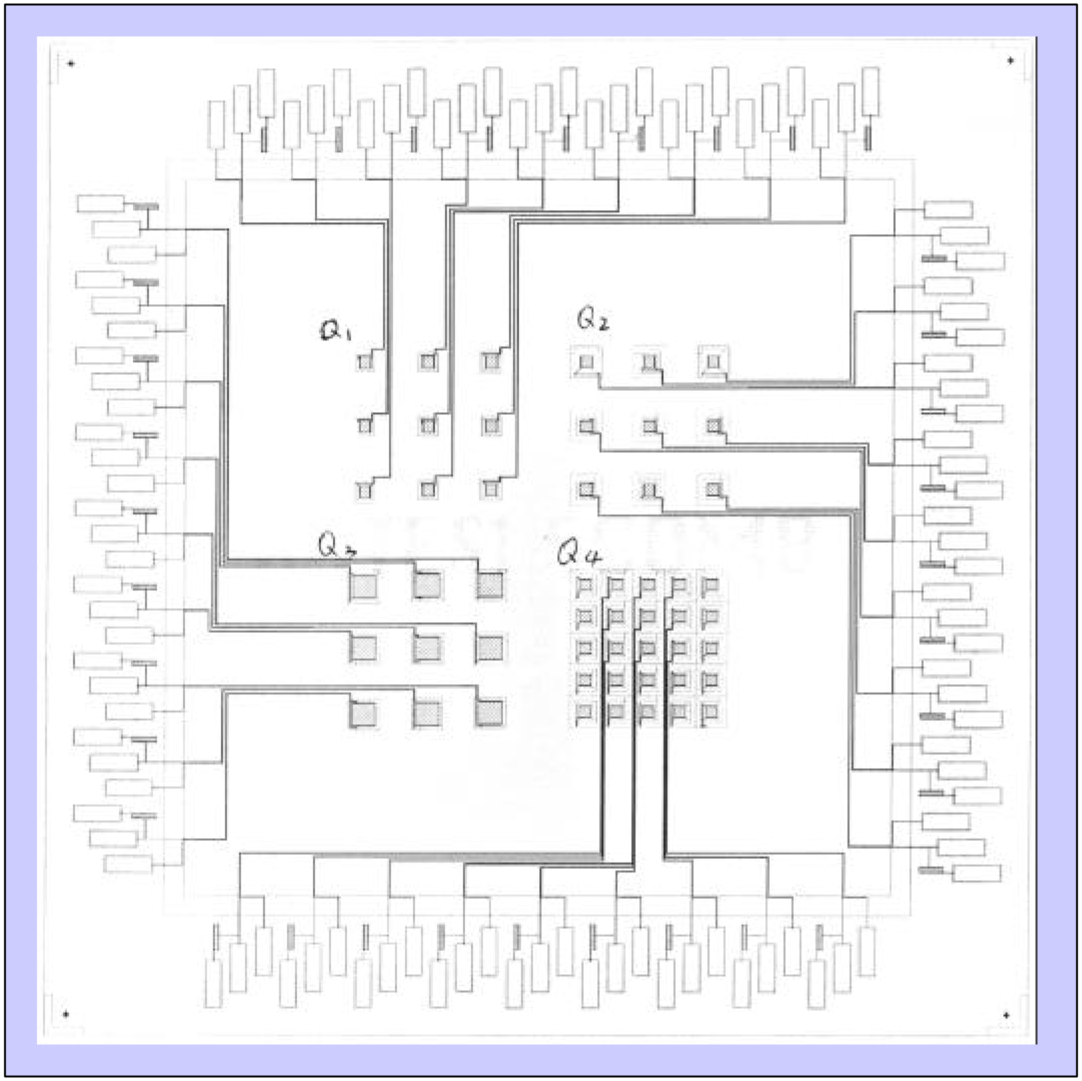
- Amplification scheme to maintain constant current bias of NTD detectors.
- “Flying lead” detectors.
- Investigating sputtering high purity Ge onto Si_3N_4 coated Si wafers. Then transmutation doped.

Unit Cell from GSFC TES Mask Design

This is one of 24 individual test devices designed to fit on a 4 inch wafer.

Each device has several 3×3 arrays with a variety of pixel geometries.

This will simultaneously allow measurements of the dependence of thermal conductance on pixel suspension geometry and evaluation of energy resolution vs. pixel size and thermal conductance.



Plans for Remainder of FY00:

GSFC

- Diagnose and remedy leak in dilution refrigerator (DR).
- Establish alternate device testing platforms in our adiabatic demagnetization refrigerator (ADR) and/or older DR.
- Put Bi absorbers on Mo/Au TES and confirm no impact on superconducting transition.
- Complete new mask set and produce test devices and arrays.
- Measure thermal conductance of the range of compact weak link geometries (perforated Si_3N_4) on the pathfinder and determine optimal design.
- Establish integrated TES array process from blank wafer through membrane and TES patterning to deposition of high-filling-fraction (mushroom) Bi absorbers.
- Characterize individual devices and arrays.
- Measure and model pathfinder position-sensitive TES strips.

NIST

- Continue to fabricate single pixel detectors with ranging parameters (and w/absorbers) for higher resolution performance.
- Fabricate small, functional TES arrays (e.g., 3×3).

Plans for FY00 (continued):

NTD-Germanium -Based
Microcalorimeter Array Development For FY2000

submitted by Eric Silver for SAO/LBNL/Brown University

1. We will emphasize array fabrication in FY2000

NTD Germanium-based arrays
Doped-Epitaxial Germanium Arrays

2. NTD Germanium-based arrays

NTD germanium is doped with almost perfect reproducibility and uniformity Impurity atom heat capacity per unit volume is 50 times lower than that of ion-implanted silicon. [But also has ~ 50 times higher sensitivity to electron-phonon decoupling.]

These properties of NTD germanium thermistors have made it possible to use NTD as a major structural element in the microcalorimeter, where all of the thermalized X-ray energy flows from the X-ray absorber through the body of the sensor.

Plans for FY00 (continued):

2-D Arrays built from from a series of stacked linear arrays of pixels

Pursue a new technology that will speed the construction of these large arrays using a novel combination of thinning, masking and etching techniques.

Sputtered Thin-Film NTD Arrays

Build a large monolithic array of thin film NTD thermistors using photolithographic and micromachining techniques on a thin film of high purity, undoped germanium.

The completed array will be exposed to thermal neutrons to produce NTD germanium with all of the uniformity benefits of bulk NTD germanium thermistors.

3. Doped-Epitaxial Germanium Arrays

Epitaxially grown thermistors can be readily processed with standard photolithographic techniques and also processed monolithically.

Starting with a substrate of high purity silicon, a thin buffer layer is grown by means of chemical vapor deposition. The buffer layer makes the transition from silicon to the epitaxial germanium.

Doping of the epitaxial layer takes place in the vapor phase.